

Globalstar TLPS Test Plan Overview

Bluetooth® TLPS Test Plan



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- **Abstract**

This document summarizes the subjective test scenarios that the Bluetooth SIG intends to test at the FCC premises. Note: these test scenarios are subject to change as we define more objectives tests. Per the FCC request, the Bluetooth SIG will utilize this test event to assess and measure the impact of Globalstar Terrestrial Low-Power Service (TLPS), where Channel 14 (2473MHz - 2483.5 MHz) would occupy spectrum that is currently used by existing Bluetooth Low Energy (LE) and Classic (BR/EDR) use cases and devices operating at the 2.4 GHz ISM band.

Revision History

Revision History	Date	Comments
r01	23-FEB-2015	Outline/First Draft
R02	26-FEB-2015	Added clarifications
R03	27-FEB-2015	Added additional over-the-air tests

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1 Scope

This Bluetooth document contains the Test Strategy and Scenarios to test Bluetooth LE and BR/EDR devices with the presence of TLPS. The objective of this Test Plan is to provide a basis for interference tests on Bluetooth LE Devices such as Hearing Aid, Blood Glucose, Proximity, etc., and Bluetooth BR/EDR devices such as Headsets and Speakers.

1.1 List of devices and test equipment:

1. Several Bluetooth BR/EDR devices, such as Headsets (HFP), Speakers (A2DP)
2. Several Bluetooth LE sensor Devices, such as Heart Rate monitors, Glucose meters, Hearing Aids, proximity, mice, etc.
3. Several smart phones, such as iPhones and Android based phones
4. Several laptop computers
5. Wi-Fi Access Points
6. Possible Spectrum Analyzer,
7. Bluetooth LE and BR/EDR Sniffers
8. Several BT/LE reference/evaluation boards,
9. Software tools to report Packet Error rate (PER) stats on each channel
10. Cables
11. Possible programmable attenuators
12. Traffic generators
13. Equipment for recording HA audio streamed over LE

2 Bluetooth SIG Participants Attending

2.1 Participants (Total around 6 participants)

Bluetooth SIG INC.: 2 resources (Jimmy Salame and Young Ming)

Cambridge Silicon Radio (CSR): 2 resources (Les Smith and a senior FAE)

Starkey: 1-2 Resources (Alexander Botz and TBD)

2.2 Test Setup Requirements

2 Days:

Tuesday, March 3rd & Wednesday March 4th

3 Test Scenarios

3.1 Wi-Fi Access Points on Channels (1, 6, 11), TLSP Channel 14 Access Point and Bluetooth connections Test Scenarios

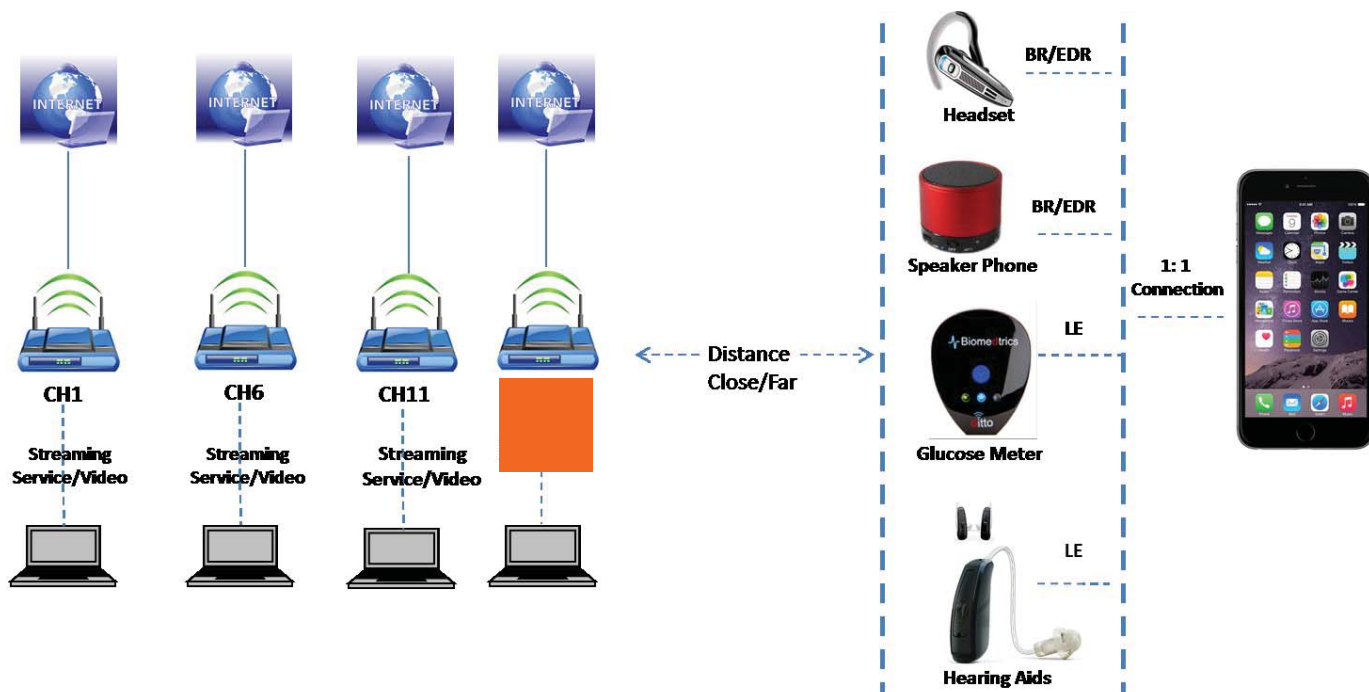


Figure 1: Illustrates expected Bluetooth Test Demonstration setup

3.1.1 Scenario 1 - Bluetooth BR/EDR Headset (HFP)

- Initial Conditions

1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off

- Test Procedure

1. With a smart phone, pair/connect with the Bluetooth BR/EDR headset, ensuring to be about 15 to 20 feet away from the APs.
2. Make a Voice call to the Bluetooth paired phone, start a conversation
3. While wearing the Bluetooth Headset, note the Audio quality and if the connection is stable and audio quality is clear.

4. While conversing, walk closer to the APs and note the audio quality, and establish a location where the audio quality is not affected.
5. While at the location where Audio quality is not affected, turn on AP #4 on CH 14/TLPS, generate TLPS traffic by streaming a Video/Netflix, and observe if there is any impact on the Bluetooth audio quality and if any chopping occurs. Move in and out from the APs and observe the Bluetooth audio quality.
6. Repeat steps 1-5 at least 5 times from different positions/locations.

3.1.2 Scenario 2 - Bluetooth BR/EDR Speaker (Stereo) A2DP Testing

- **Initial Conditions**

1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off

- **Test Procedure**

1. With a smart phone, pair/connect with the Bluetooth BR/EDR Speaker, ensuring to be about 15 to 20 feet away from the APs.
2. Start streaming music from an app like Tune in radio
3. While music is streaming to the Bluetooth Speaker, note the music quality and if the connection is stable and if music quality is clear.
4. Move the Bluetooth Speaker closer to the APs, while music is streaming, and note the audio quality, and establish a location where the audio quality is not affected.
5. While at the location where Audio quality is not affected, turn on AP #4 on CH 14/TLPS, generate TLPS traffic by streaming a Video/Netflix, and observe if there is any impact on the Bluetooth streaming music quality and if any chopping occurs.
6. Repeat steps 1-5 at least 5 times from different positions/locations.

3.1.3 Scenario 3 - Bluetooth LE Hearing Aid (HA) Testing

- **Initial Conditions**

1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.

3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off.

- **Test Procedure**

1. With a smart phone, pair/connect with the Bluetooth LE HA device, ensuring to be about 15 to 20 feet away from the APs.
2. Make a Voice call to the Bluetooth paired phone, start a conversation
3. While wearing the Bluetooth HA, note the Audio quality and if the connection is stable and audio quality is clear.
4. While conversing, walk closer to the APs and note the audio quality, and establish a location where the audio quality is not affected.
5. While at the location where Audio quality is not affected, turn on AP #4 on CH 14/TLPS, generate TLPS traffic by streaming a Video/Netflix, and observe if there is any impact on the voice quality and if any chopping occurs. Move in and out from the APs and observe the quality.
6. Note a location where the Audio quality is affected, un-pair/disconnect the Bluetooth LE connection with the HA.
7. From the same location/position, try establishing a connection again with the HA device, note if a connection is successful or not.
8. Repeat steps 1-7 at least 5 times from different positions/locations.

3.1.4 Scenario 4 – Bluetooth LE Blood Glucose Meter Testing

- **Initial Conditions**

1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off.

- **Test Procedure**

1. With a smart phone, pair/connect with the Bluetooth LE Blood Glucose Meter device, ensuring to be about 15 to 20 feet away from the APs.
2. Allow the Glucose meter sensor to go to sleep, and then wake up the sensor ensuring the device reconnects successfully.

3. Walk closer to the APs and, and repeat step 2 several times ensuring the device reconnects successfully.
4. While at the location where a successful frequent connection was established, disconnect the Glucose sensor device, and, turn on AP #4 on CH 14/TLPS, generate TLPS traffic by streaming a Video/Netflix.
5. From the same location/position, try establishing a connection again with the Glucose sensor device, note if a connection is successful or not.
6. Repeat steps 1-6 at least 5 times from different positions/locations.

3.1.5 Scenario 5 –Perform similar tests with Bluetooth LE Heart Rate monitors, Proximity devices, etc.

- **Initial Conditions**

5. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
6. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
7. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
8. Access Point (AP) #4 on CH 14/TLSP Interferer turned off.

- **Test Procedure**

Perform similar tests as described in Scenario 1-4.

3.2 Over-The-Air Testing

The Bluetooth SIG participants will run over-the air testing and report measurement responses for analysis. These measurements include testing with the presence of a TLPS AP (On/OFF) on CH 14, other APs on CH1, CH4, CH 6, CH 11 with streaming traffic, examining and reporting connection disruptions or delays in establishing connections, measuring Bluetooth LE data transmissions performance, audio performance degradation, measuring Out-of-Band emissions, Packet Error Rate (PER) impact, data throughput impact, measuring the impact on Bluetooth Channels such as Bluetooth LE advertising CH 39 with the presence of TLSP AP interferer, assessing Bluetooth LE frequency hopping performance impact with fewer data channels available to hop on and backing off in the remainder of the ISM band.

3.2.1 Scenario # - Bluetooth LE Hearing Aid (HA) Programming Testing

- **Initial Conditions**

1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off.
5. Setup an Ellisys 400 protocol analyzer for BLE channel traffic monitoring

- **Test Procedure**

1. Setup two laptops, each equipped with a Bluetooth dongle. Power on two pairs of HA devices. The HA devices are placed on two respective human subjects. The HAs and BT dongles are separated by 3 to 5m in all instances of the test.
2. Discover one HA device with one laptop and the other pair with the other laptop respectively.
3. Initialize test software that emulates a HA programming session
4. While the test is in progress, the HA user moves closer to the APs while another user monitors throughput and PER on the test GUI, and establish a location where the link is not affected.
5. While at the location where the link is not affected, turn on AP #4 on CH 14/TLPS, generate TLPS traffic by streaming a Video/Netflix, and observe if there is any impact on the PER or data throughput. Move in and out from the APs and observe the PER and throughput on the test GUI.
6. Extract PER and throughput statistics from the laptops running the test software, and Ellisys protocol analyzer trace.

3.2.2 Scenario # - Bluetooth LE Hearing Aid (HA) Audio Testing

- **Initial Conditions**

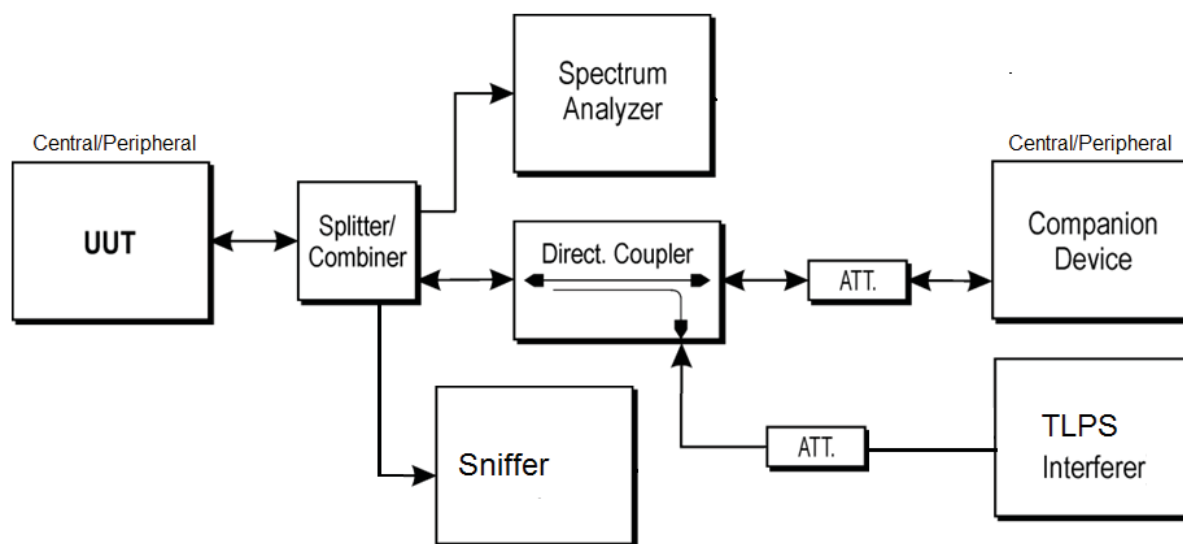
1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off.
5. Setup an Ellisys 400 protocol analyzer for BLE channel traffic monitoring

- **Test Procedure**

1. Pair/connect 3-4 iPhones with 3-4 pairs of respective Bluetooth LE HA devices, ensuring to be about 15 to 20 feet away from the APs.
2. Start an audio stream on each iPhone using the Apple music player
 - a. One HA pair is worn on the ears of a human subject and the iPhone is placed in a pants pocket.
 - b. One HA pair is worn on the ears of a human subject and the iPhone is placed on a desk/table/stand 5m away.
 - c. One pair of HAs is placed on a desk/table/stand with equipment attached to the audio receivers to record the streamed audio over LE. The iPhone is placed on a desk/table/stand 5m away.
 - d. (Optional) One HA pair is worn on the ears of a human subject and the iPhone is placed on a desk/table/stand 5m away.
3. While wearing the Bluetooth HA, note the Audio quality and if the connection is stable and audio quality is clear.
4. While listening, walk closer to the APs and note the audio quality, and establish a location where the audio quality is not affected.
5. While at the location where Audio quality is not affected, turn on AP #4 on CH 14/TLPS, generate TLPS traffic by streaming a Video/Netflix, and observe if there is any impact on the voice quality and if any chopping occurs. Move in and out from the APs and observe the quality.
6. Note a location where the Audio quality is affected, un-pair/disconnect the Bluetooth LE connection with the HA.
7. From the same location/position, try establishing a connection again with the HA device, note if a connection is successful or not.
8. Repeat steps 1-7 at least 5 times from different positions/locations. Repetition of the above steps should be done to insure at least 30 minutes of audio quality is listen to, recorded, and evaluated.
9. Extract PER statistics from the iPhones, Ellisys protocol analyzer trace, and recorded HA audio upon completion of the test.

3.3 TLPS Interferer Cabled Test Procedure (Deferred)

Note: This test cannot be supported at this test events, since the TLPS AP provided by Globalstar does not support a cabled connection such as an attenuator



3.3.1 List of Devices

1. Programmable attenuators
2. TLPS radio with cabled connector capability at antenna port
3. Spectrum analyzer
4. 2 BT/LE reference boards with SMA connector, software tool to report Packet Error rate (PER) stats on each channel
5. Cables (cable loss needs to be calibrated)
6. BT/LE sniffer

3.3.2 Scenario 5 - Bluetooth LE Receiver Testing

This test verifies the receiver's performance in presence of TLPS interferer

- **Initial Conditions**

1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off.

- **Test Procedure**

3.3.3 Scenario 6 - Bluetooth LE Advertiser Testing

This test verifies the advertiser's performance in presence of TLPS interferer

1. Access Point (AP) #1 on CH 1, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
2. Access Point (AP) #2 on CH 6, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
3. Access Point (AP) #3 on CH 11, turned on, an internet connection, and a streaming service such as a Video/Netflix is running.
4. Access Point (AP) #4 on CH 14/TLSP Interferer turned off.

- **Test Procedure**